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THAWING FROZEN WATER MAINS AND SERVICE PIPES BY ELECTRICITY[1]

By W. I. McMane

The thawing of frozen water pipes with electric energy taken from central station mains has come to be a familiar practice and may be accomplished in various ways. Among them are the following: By using one or more transformer units to change energy from distribution pressure to a suitable pressure for the work; by using energy direct from low-voltage alternating current or direct-current service wires, or by a portable gasoline-engine-driven generator.

The Commonwealth Water Company, operating water utilities in several municipalities in northern New Jersey, had its first experience in electrical thawing during the winter of 1905, which for a short period was extremely cold and with very little snow on the ground to prevent the frost from penetrating to a considerable depth. In some cases the frost went to a depth of 5 feet, freezing some of the mains and many of the service connections. One of the first complaints received was in a street where there was a 6-inch main in very open gravel soil, with about 4 feet 6 inches of cover, and paralleling the main was an open sewer trench. In many places the sewer excavation had bared the main in sections from 10 to 50 feet in length, resulting in freezing approximately 700 feet of the 6 inch main, thereby cutting off the water for domestic and fire service uses.

In order to restore the service as quickly as possible, it was decided to assemble an emergency thawing apparatus. Accordingly there were loaded on a wagon the largest transformer in stock, with the necessary switches, a reel of wire and an oil barrel filled with water to use as a rheostat. The outfit was hauled to the frozen main. A sufficient amount of wire was then unreeled to reach from the transformer to the nearest fire hydrant. One connection was made on the revolving top nut of the hydrant, and the other line was connected to a service, on a service key placed on a service curb cock. It was assumed that it would require several hours to remove the ice obstruction, but after turning on the current at 10.00 a.m., at 12.30 the ice obstruction had been completely removed and without any damage to the main or house connections.

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[1] Read before the Richmond Convention, May 10, 1917.

When it is possible to obtain the current from the central station supply, it is cheaper and better to use this source of energy. If the supply is direct current of 110 or 220 volts, it may be used directly from the lines, the only equipment necessary being a rheostat to control the current within proper limits and possibly an ammeter to measure the current. If the supply is alternating current the same arrangement may be used, providing there is sufficient capacity available at 110 or 220 volts. Ordinarily this is not the case, a sufficient supply only being available at a much higher voltage, usually 2200 volts, which condition exists in the territory of the Commonwealth Water Company and it is necessary to have equipment suitable for operation from 2200-volt alternating-current circuits. The high voltage current may be reduced to proper working voltage by means of suitable transformers. If ordinary distribution transformers are used it is necessary, in order to give a sufficient amount of adjustment, to use three or four transformers connecting them up in various combinations to produce the desired results. Several electrical equipment companies are now building transformers especially designed for this work, known as "pipe thawing transformers," which are adjustable and by simply turning a wheel or handle the desired current may be obtained. They are also designed to have a certain amount of inherent regulation, thereby fixing the amount of current obtainable within certain safe limits, whereas with ordinary distribution transformers a dangerous amount of current might be obtained with improper connections.

The method of thawing frozen main or service connections with a special pipe thawing transformer such as the Commonwealth Water Company is now using, is as follows:

Two wires are connected from the high-tension street wires to one side of the transformer and two wires are connected to the other side of the transformer, one of which is run into the building having the frozen service and attached to any convenient part of the piping in the house, but preferably at a faucet, as this is the only means of being absolutely sure that the connection is inside of the frozen section. The other wire is usually connected to a hydrant, but should no hydrant be available a key may be placed in a convenient curb box and the wire attached to the key, or the wire may be run into another house and attached to the piping there. It must always be remembered that the current flows along one wire to the pipe and from that point through the pipes to the other wire, the pipe between these two connections being heated more or less, depending first upon the amount of current passing and second upon the diameter of the pipe. Should the connection be made to a curb cock and the frozen portion happen to be between the curb cock and the main, the desired result would not be obtained, whereas if it is attached to a hydrant or service in an adjacent building the current must necessarily pass through the entire length of service from the faucet to the main. In thawing house service connections it is always good policy to disconnect the pipe being thawed from the remainder of the house plumbing, which eliminates the possibility of shunted current, which requires a longer period of thawing and creates a possible fire risk. When all connections are complete, the circuit is closed by putting in the fuse plugs on the high tension side, the transformer having been previously set to give the minimum amount of current. The transformer is then regulated to produce whatever current is desired up to its maximum amount.

For thawing out pipes up to a 1-inch a 15 kilowatt transformer is of ample size, and with such a transformer pipes even as large as 3 or 4 inches may be thawed if the current be supplied for a sufficient length of time. The work sometimes requires 3 or 4 hours application of as much as 200 amperes. In thawing ordinary ¾-inch services 100 amperes is sufficient to start the flow of water in from five to ten minutes. Ordinarily no harm is done by using 150 or even 200 amperes on a ¾-inch service, if so much current will flow. It will be found, however, that it is not always possible to obtain so much current as can be conveniently used, due to the fact that the length of pipe in the circuit may be sufficient to hold the current down to a relatively low value, even though the transformer be set at its highest point. Unless at least 20 amperes can be obtained, it is not usually feasible to thaw a ¾-inch service, and with that current it might require three or four hours application. One hundred and fifty amperes will usually thaw a 1-inch pipe in about twenty minutes and a 2-inch pipe in one-half to three-quarters of an hour.

The special pipe thawing transformer has been found useful in thawing out leader or drain pipes, pump suction lines, etc., that have been subjected to freezing conditions. In one instance, 600 feet of cast iron pipe were frozen, and not having any means of telling just when the ice was removed the current was applied for so long a period as to generate a sufficient amount of heat to flux the lead joints. This instance, however, is the only one where electrical thawing has caused the company any repair expense.

When drain or waste pipes from boilers are placed in exposed positions, subject to freezing, a very good plan is to have installed along the central axis of the drain, a small-diameter iron pipe. Permanently fastened wires can then be connected to each end of the pipe and when ice clogs the drain the small pipe can be heated electrically until the ice core is melted enough to allow the hot water from the boiler to drain through and complete the thawing.

Many of the electric light companies now maintain suitable equipment for electrical thawing, which work is done under an agreement with the water companies. It is quite necessary to have at least one experienced lineman connect the high-tension wires, connect the wires from the transformer to the water pipe, regulate the transformer, etc. While the use of such an equipment is not particularly dangerous, except in making the connection to the high-tension wires, it might prove more or less dangerous if attempted by someone inexperienced in this line of work. It is therefore good policy to have the local electric company do this work until such time as the water department's employees are thoroughly familiar with the proper handling of the apparatus.

During the winter of 1916 and thus far in 1917, our machine has been used in thawing twenty service connections. The machine has operated with perfect satisfaction and in no case has it failed to give relief. The average cost per service, including labor, carting and interest and depreciation charges, was approximately $5.00, which expense is borne by the company, no charge being made to the consumer.

DISCUSSION

THEODORE A. LEISEN: In Detroit services are installed at the expense of the consumer, who is required to pay for all repairs, including thawing. The Detroit Edison Company thaws the services at a flat rate of $10, regardless of the size of the pipe. The number of services thawed each winter is between 50 and 100, and none of them exceeds 1 inch in size.

The speaker desires further information from Mr. Machen regarding the condition of the contents of the pipes when the ice begins to thaw; does the ice come out in the form of a solid core or is it entirely melted? It will also be instructive to learn if there was any radical change in the temperature of the water from February 12 to March 12.

J. Walter Ackerman: In such work as the papers on thawing frozen water mains describe, the responsibility for restoring a frozen pipe to service is of importance. In Auburn, N. Y., the portion of the service pipe from the curb stop to the house belongs to the property owner and he must look after it. The portion from the curb stop to the main must be looked after by the water department, which does not have the same control over the laying of the part beyond the curb stop that it has over the part in the street. This difference in responsibility may make a difference in the best method of thawing mains by contract with an electric company.

Frank C. Kimball: All the service pipes of the Commonwealth Water Company are laid at the expense of the consumer, but the company maintains the street portion of them indefinitely and also maintains for fifteen years the part from the street to the building when it lays the pipe itself. As a consequence the company regards restoring a frozen service pipe as part of its maintenance work, for freezing can only occur from laying the pipe at an insufficient depth to prevent it, which is certainly not the fault of the property-owner.

E. J. Jenkins: During the past winter the East Chicago & Indiana Harbor Water Company thawed out 27 services electrically, for which the Northern Indiana Gas & Electric Company charged $15 per service. There is no question but what this price is unreasonable, and is due to labor conditions. For this work, they used a truck, and what the local union calls a regular gang of five men, while the work could be taken care of with two men. This labor expense, and the use of a 3-ton motor truck, was the cause of the work costing so much. The speaker does not think that the steam method is to be compared with the electrical method, where lead pipe is used for services. It is impossible to lay lead pipe perfectly straight, and it is impossible to work a steam line through pipe that is not perfectly straight. If services were run with galvanized iron pipe, which would be perfectly straight, steam would be the ideal thing to use.

The following notes were furnished by Mr. Crawford, of the Northern Indiana Gas & Electric Company.

The use of electricity for thawing out frozen underground water pipes requires a transformer, say, of 10 or 20 kilowatts capacity, which can be taken to the locality required, connecting the primary with the high-tension circuit passing the place, and then connecting the secondary through an ampere meter and rheostat to the service in trouble. Where services from the street mains to two adjacent houses are both frozen, it is only necessary to connect the secondary circuit to the kitchen faucets of both houses and thus the circuit is complete through the service of one house to the street main and back through the service to the second house.

Where the service of but one house is to be thawed, one end of the secondary circuit is connected to the kitchen faucet and the other end to the nearest street hydrant or other street connection. Currents of 20 to 500 amperes are used, obviously varying according to the conditions; and the time taken to thaw the ice sufficiently to start the water running will be from ten to forty-five minutes or perhaps three to eight hours, according to circumstances. The average time for the ordinary house service will seldom exceed forty-five minutes, while for a 5 or 6-inch pipe that has been frozen solid the highest amount of current and time mentioned will be required.

It is very seldom necessary to melt the entire plug of ice, as the thawing of a thin sheet next the metal will start the water running and that will consume the ice in a short time.

The following table is compiled from data that have appeared in various periodicals. It represents average conditions for last year, and shows what may be expected in the future.

Average conditions for thawing frozen pipes

SIZE PIPE	LENGTH	VOLTS	AMPERES	TIME REQUIRED TO THAW
inches	*feet*			
¾	40	50	300	8 minutes
¾	100	55	135	10 minutes
¾	250	50	400	20 minutes
1	250	50	500	20 minutes
1	700	55	175	5 hours
4	1300	55	260	3 hours
10	800	70	400	2 hours

Robert L. Clemmitt: In Baltimore there is seldom trouble from frozen pipes, except in unusually cold winters. In January, 1912, the weather was very severe and quite a number of services froze and the water department had some unique experiences in connection with them. On one occasion, when thawing the frozen services by electricity, the gas and water pipes were in contact in the cellar of the property where the work was done. The current caused the lead connections to the gas meter to fuse and ignite the escaping gas, and but for the presence of experienced men a serious fire would have resulted. On another occasion, when working on a service at night, the men noticed that it took quite a long time to get results, and at the same time the gas company was having considerable trouble in a lower lying section of the city adjacent to where these men were working. All the gas lights went out and the gas company's telephones were kept busy. It was finally found that the water service pipe being thawed was in contact with a gas service which it crossed at right angles, and that the currrent had made an arc between the two and welded them together, leaving about a $\frac{3}{8}$-inch hole through from the water to the gas service. When the water service was finally thawed the water, of course, flowed into the gas pipe, with the result that all the gas distribution system in a large section of the city, probably a square mile, was charged with water under pressure.

G. O. House: Although the winter temperature at St. Paul remains below 20° below zero for a month at a time, the water department does not have a great amount of trouble with frozen services because it is organized to take care of them. During the last year about a thousand cases of freezing were treated, at a flat rate of $5 per service, which more than repays to the water department the cost of the service rendered.

The work is done with an independent generating set made for the purpose at a cost of $2700. A gasoline engine drives a generator which furnishes current up to 500 amperes at 40 volts; it is seldom necessary to use a current of more than 250 amperes at 25 volts. This outfit is mounted on a trailer, from which it can be removed when the cold weather is over. It has been found possible to thaw any frozen pipe up to 2 inches in size in about five minutes with this outfit.

During the last winter the water department has permitted consumers to allow water to run through services which became frozen. In case a service freezes, a note to that effect is placed on the ledger, the water is allowed to run during the periods when freezing may recur, the meter readings are kept during these periods, but the bills are rendered in accordance with previous readings during that period. The past winter is the first during which this system has been followed and it is not yet possible to give the percentage increase in consumption during the cold weather as a result of this practice. As the department tells the owner of a building how deep he must have the service pipe laid, it should assume all responsibility for frozen pipes outside buildings.

R. J. JOHNSON: The experience of Saginaw with the thawing of frozen mains by contract with the local electric light company was unsatisfactory. The work was not done promptly and the cost of $6 was considered too high. A portable generating plant was obtained and last winter about 300 services were thawed out during a period of ten weeks of zero weather at an average cost of less than $3 each. The promptness with which the services were thawed was much appreciated by the public after its experience with the tardy work of the electric company.

HARRY F. HUY: During 1912 the Western New York Water Company had occasion to determine the cost of thawing services in the city it supplied with water. There were about 800 services thawed electrically in conjunction with the Electric Public Service Company. This cost was considerably more than $3; in fact, it was agreed that the proper charge would be about $8 per service, to allow for overhead charges, investment and maintenance.

There is no way to prevent services from freezing again except by lowering them to the proper depth or taking other means to insulate the pipes. The best thing to do is to reinstall the service pipe properly for it is not fair to either the water works man or the taxpayer to allow consumers to leave their faucets open and waste water during freezing weather.

H. B. MACHEN: From the prices charged as stated by the various speakers, it appears that the New York City charges are based on a service rendered basis, and are not a direct function of the actual cost of the work performed. However, the saving to the property owner using electricity for freeing ice on a service connection is so great compared to the methods heretofore followed that it has not appeared excessive.

The advantages of doing the work by municipally owned and operated equipment such as referred to by Mr. House of St. Paul appear to warrant any city where freezing service mains may occur in investing in a gasoline-engine-driven electric equipment, which should not cost more than $2,000 mounted on small autotrucks.

Answering Mr. Leisen's questions, in thawing out the line the current heated the pipe and melted a portion of the ice immediately adjacent to the metal. Owing to the considerable amount of curvature, however, the ice cores did not force their way through, but with the flow of the heated water rapidly disappeared, so that by the end of the day a full and free flow of water appeared. The temperature was taken at varying depths in a rather crude manner, using the ordinary recording maximum and minimum thermometer. On February 24 with 40° in the air, the surface water had a temperature of 22°, and at a 50-foot depth 29° was reached. On March 5 the temperature at a 15-foot depth was 29°.

It has not been possible to test the 6-inch line after thawing, as no other line was available for supply to the Island. Recently a new submarine line has been completed and it is expected with the near future to pass a satisfactory acceptance test, so that it will be possible to use the 12-inch main for service and make tests on the 6-inch main. However, the results may not be fair to the line, as it has been through several severe trials between 1912 and the present time. On one occasion a schooner dragging its anchor picked up the 6-inch main. It was necessary to cut the cable and abandon the anchor in order to prevent the heavy drag of the schooner pulling the main out of position.